Research in Developmental Disabilities 34 (2013) 4017–4024

Contents lists available at ScienceDirect

Research in Developmental Disabilities

A physical fitness follow-up in children with cerebral palsy receiving 12-week individualized exercise training

Shiau-Chian Jeng [a,1], Kuo-Kuang Yeh [b,1], Wen-Yu Liu [a], Wei-Pin Huang [a,c], Yu-Fen Chuang [a,d], Alice M.K. Wong [e], Yang-Hua Lin [a,d,*]

[a] Department of Physical Therapy and Graduate Institute of Rehabilitation Science, College of Medicine, Chang Gung University, 259 Wen-Hwa 1st Road, Kwei-Shan, Tao-Yuan 333, Taiwan
[b] Physical Therapy Division, Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital, 5, Fu-Hsing Street, Kwei-Shan, Tao-Yuan 333, Taiwan
[c] Department of Physical Therapy, HungKuang University, 1018, Sec. 6, Taiwan Boulevard, Shalu District, Taichung City 43302, Taiwan
[d] Healthy Aging Research Center, Chang Gung University, 259 Wen-Hwa 1st Road, Kwei-Shan, Tao-Yuan 333, Taiwan
[e] Department of Physical Medicine and Rehabilitation, Chang Gung Memorial Hospital, 5, Fu-Hsing Street, Kwei-Shan, Tao-Yuan 333, Taiwan

ARTICLE INFO

Article history:
Received 15 July 2013
Received in revised form 19 August 2013
Accepted 19 August 2013
Available online

Keywords:
Cerebral palsy
Physical fitness
Health-related quality of life
Follow up
Exercise training

ABSTRACT

Physical fitness in children with cerebral palsy (CP) is lower than in their peers. A 12-week individualized home-based exercise program completed by 11 children with CP 10 years earlier showed a favorable effect on physical fitness performance. We follow-up the physical fitness of those 11 children with CP, and compare their physical fitness and health-related quality of life (HRQoL) to children with CP without exercise training matched with age and motor levels. Eleven children with CP in the 2003 program as a follow-up group (FUG) and 12 volunteers recruited as a control group (CG) participated in this study. Physical fitness measures, including cardiopulmonary endurance, muscle strength, body mass index (BMI), flexibility, agility, balance, and the SF-36 Taiwan version, were assessed in both groups. After 10 years, the FUG showed better physical fitness in cardiopulmonary endurance and muscle strength ($p < .05$). Compared to the CG, the FUG demonstrated better muscle strength, agility, and balance ($p < .05$). However, the HRQoL did not show a significant difference between the FUG and the CG. Individualized home-based exercise training is beneficial for children with CP. Over 10 years, the FUG was more devoted to physical activity than was the CG. Physical exercise may not directly affect the HRQoL in this study.

1. Introduction

Physical fitness is important for achieving daily tasks and enjoying leisure activities. Certain health- and skill-related components are attributed to physical fitness (Caspersen, Powell, & Christenson, 1985; Pate, 1983). The health-related components include cardiorespiratory endurance, muscular endurance, muscular strength, body composition, and flexibility. The skill-related components include agility, balance, coordination, speed, power, and reaction time (Caspersen et al., 1985). Children with cerebral palsy (CP) have reduced physical fitness levels compared to typically developing children

* Corresponding author. Department of Physical Therapy, College of Medicine, Chang Gung University, 259 Wen-Hwa 1st Road, Kwei-Shan, Tao-Yuan 333, Taiwan. Tel.: +886 3 2118800; fax: +886 3 2118700.
E-mail address: linyh@mail.cgu.edu.tw (Y.-H. Lin).
[1] The first two authors contributed equally to this work.

0891-4222/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ridd.2013.08.032

because motor impairments impede their involvement in physical activities and sports (Turk, Overynder, & Janicki, 1995; van den Berg-Emons et al., 1995). Studies have indicated that children with CP have subnormal aerobic and anaerobic capacity (Kusano, Iwasaki, Tobimatsu, & Suyama, 2001; Stout, 2006), decreased muscle strength (Damiano, Kelly, & Vaughn, 1995) and endurance (Parker, Carriere, Hebestreit, & Bar-Or, 1992) compared with typically developing peers. Children with CP lack flexibility because of muscle tightness that limits their joint motion, and are at risk of pain and loss of balance and mobility. Studies have also indicated abnormal body composition in schoolchildren with CP with low physical activity and malnutrition (Berg, 1970).

The Pediatric Research Summit by the American Physical Therapy Association suggests that physical fitness can reduce many secondary conditions in people with CP (Fowler et al., 2007), and can help improve posture, muscle tone, and balance in people with CP. A conclusion from the literature reviews suggested that cardiorespiratory training in children with CP may improve aerobic fitness (Butler, Scianni, & Ada, 2010; Pitetti, Fernandez, & Lanciault, 1991; Unnithan et al., 2007; van den Berg-Emons, Van Baak, Speth, & Saris, 1998), although the carryover into activity is limited. Researchers have indicated that muscle-strengthening programs for 6–8 weeks not only increased strength and improved gait performance (Damiano et al., 1995) in children with CP, but also improved sit-to-stand capability (Taylor, Dodd, & Larkin, 2004). A short program of task-specific strength training as a group circuit class for children with CP resulted in improving strength and functional performance that was maintained over time (Blundell, Shepherd, Dean, Adams, & Cahill, 2003). A randomized controlled trial reported that an exercise training program improved physical fitness, the participation level, and the quality of life in children with CP when added to standard care (Verschuren et al., 2007), whereas clinical research evaluating the effects of stretching exercise is inconclusive (Wiart, Darrah, & Kembhavi, 2008). Research on the management of children with CP has suggested an increased emphasis on flexibility, fitness, and participation in activities that are meaningful to children and families (Wiart et al., 2008). Standing (Dimension D) and walking, running, and jumping (Dimension E) of the Gross Motor Function Measure have demonstrated moderate to high associations with short-term muscle power, agility, and functional muscle strength; however, they are not related to aerobic capacity and body mass index (BMI) (Verschuren, Ketelaar, Gorter, Helders, & Takken, 2009). Physical fitness components may importantly direct specific interventions to maximize gross motor capacity in people with CP. Our research group (Jeng, Hwang, & Liu, 2011) provided a 12-week individualized home-based exercise program for children with CP, consisting of cardiopulmonary endurance, muscle strength, flexibility, agility, and balance, which significantly improved muscle strength, balance and agility.

Bryant, Pountney, Williams, and Edelman (2013) showed that 6-week exercise intervention with bike and treadmill improved gross motor function for non-ambulant children with CP; however, the improvements declined during the follow-up period at 12 weeks and 18 weeks. In a 4-month follow-up after training conducted by Verschuren et al. (2007), the aerobic and anaerobic capacity for the group that received 8-month training decreased to 4-month levels, whereas the control group showed no significant change; health-related quality of life (HRQoL) measures were similar for the training versus control group. Moreover, the data on long-term outcomes of exercise training are limited.

The purpose of this study was to follow up the physical fitness of the 11 children with CP who received individualized exercise training 10 years earlier to compare their physical fitness and the HRQoL to those with CP who did not receive exercise training.

2. Methods

2.1. Participants

Eleven people with CP who had completed a 12-week individualized home-based exercise training program in 2003 were recruited for this study as a follow-up group (FUG). For a control group (CG) comparison, 12 age-matched volunteers with CP without any experience in receiving exercise training were enrolled. All participants were classified at Gross Motor Function Classification System level I. The participants who could not follow verbal commands were excluded. The Institutional Review Board of Chang Gung Memorial Hospital reviewed and approved this study. Written informed consent was obtained from the participants if they were adults, or from their parents after an explanation of the study purpose and protocol.

2.2. Physical fitness measures

2.2.1. Cardiorespiratory endurance

To measure cardiorespiratory endurance, we employed a 6-min walk test (6MWT) administered on a treadmill (GaitKeeper 1800T; Mobility Research, Tempe, AZ, USA), which has been demonstrated as a predictor for peak VO_2 (Mossberg & Fortini, 2012), and shown no difference from the test results on level ground (Elazzazi, Chapman, Murphy, & White, 2012). During a 6-min period, participants were instructed to walk on a treadmill at a self-selected speed as fast as possible. The heart rate was monitored using the pulse oximeter (Model 200; Novametrix Systems Inc., Wallingford, CT, USA). The distance walked was registered for calculation by dividing the heart rate (beats/min) by walking speed (meters/min) as the physiological cost index (PCI, beats/m).